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ABSTRACT

The purpose of this experiment was to present redundant auditory information along with written displays to see if first graders would be aided in discrimination between legal and illegal nonwords. Seventy-two middle-class first and second graders of both sexes were given one of three treatments to study the effect of redundant auditory information on nonword discrimination. Half the subjects in each treatment scored high and half low on the Auditory Analysis Test (AAT). In the visual condition subjects saw each member of a nonword pair sequentially on slides. In the auditory condition the subject heard the words pronounced by an experienced linguist who attempted to pronounce the illegal nonwords like foreign words, avoiding the regularization of their pronunciation. In the combined condition subjects saw the words and heard them pronounced at the same time. The task in all conditions was to say whether the first or the second word of the pair was more like a real word. The results indicated that the main effects of grade, condition, and words were significant. There was no main effect for sex. An additional findings was that children's performance on the task of identifying words when both clusters were illegal was no easier than with either cluster illegal. (WR)

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CHILDREN'S DISCRIMINATION OF ENGLISH SPELLING PATTERNS WITH REDUNDANT AUDITORY INFORMATION

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The skilled reader has abstracted many redundancies and constraints within and between words to enable him to process the information in text in the largest possible units appropriate for the task (Anderson, 1937; Huey, 1908; Gibson & Levin, 1974). How is the ability to make use of the rule systems available in written language acquired? This paper reports an experiment which examined the pick-up of intra-word structure - a skill essential for rapid word perception - in beginning readers.

Classic experiments performed by Cattell in 1885 found that skilled readers could recognize a word presented tachistoscopically faster than a single letter in isolation. Cattell attributed this "word-superiority effect", as it is often called, to the fact that words have meaning. However, this result occurs even when the stimulus word does not have meaning but is constructed according to the phonological and orthographic rule systems of the stimulus language. What is it about real words, and words that are constructed like them, that makes them easier to recognize or remember or identify? English and other languages have conditional rule systems for spelling and pronounciation that describe the way a word in that language may sound or be spelled (Whorf, 1940; Venezky, 1970). For example, of the more than 150

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consonant clusters in English most can appear only in the initial or final position in the word (Fries, 1963). Consider a word like cling. Another vowel could be inserted in the center and it would still look like a possible legal English word. But reverse the initial and final consonant clusters and the result - ngicl - is a word that skilled readers would never mistake for an English word. Also, cl and ng and other consonant clusters are pronounced essentially the same way whenever they appear. These positional constraints and phonological regularities provide enormous redundancy for the reader because they give information beyond the single letter for what the word might be.

When Gibson, Pick, Osser and Hammond (1962) found that adults perceived words constructed according to English spelling and sound patterns more accurately than words not so constructed, she and her students gave similar tasks to children at various stages of learning to read. The results of these studies suggest that some children, even in the first grade, have begun to note common spelling patterns and their pronounciations in a way that reduces the information that text presents. Some children reliably distinguished words like ran, and legal nonwords like nar, from illegal nonwords like rna (Gibson, Osser & Pick, 1963). By the third grade children's performance ranged from 69-80 percent correct (Rosinski & Wheeler, 1972). Evidently many English spelling patterns and the redundant auditory information they map to, are being abstracted between the first and third grade.

At Cornell Dr. Gibson and I were surprised to find that second graders by March of the school year were doing as well as third graders on the discrimination between legal and illegal nonwords (Golinkoff, 1972). For theoretical as well as instructional purposes, it seemed important to determine what information children used to enable them to abandon less efficient letter-by-letter processing so soon after learning to read.

Children could be using the information present in the written code, or a combination of the visual information and the redundant auditory information available from the many regularities in English spelling-to-sound correspondences. Apparently, auditory information is not necessary for this discrimination since deaf adult readers perceive legal nonwords better than illegal nonwords (Gibson, Shurcliff & Yonas, 1970). Thus, the auditory information that can be generated in this discrimination is redundant in the way that Garner (1962) has defined redundancy: auditory information adds a new dimension for discrimination since it covaries with levels of the original stimulus. However, even though the auditory information is not essential, perhaps normal hearing children are using their knowledge of the sounds of their language to help in abstracting these regularities. This contention is supported by two lines of research. First, it has been shown that by age three children are aware of many of the phonological constraints of their native language, e.g., Messer (1967). Second, research by my colleague Jerome Rosner (1971), indicates that children's ability to conceptualize and operate on their aural language predicts early success in reading. Thus, the main purpose of this experiment was to present redundant auditory information along with written displays to see if first graders would be aided in their discrimination between legal and illegal nonwords.

Method and Procedure

Middle-class first (n=36) and second (n=36) graders of both sexes were given one of three treatments to study the effect of redundant auditory information on nonword discrimination. Half the subjects in each treatment scored high and half low on the Auditory Analysis Test (AAT) (Rosner & Simon, 1970). In the Visual condition subjects saw each member of a nonword pair sequentially on slides. In the Auditory condition the subject heard the words pronounced by an experienced linguist who

attempted to pronounce the illegal nonwords like foreign words, avoiding the regularization of their pronounciation. In the Combined condition subjects saw the words and heard them pronounced at the same time. The subjects' task in all conditions was to say whether the first or the second of the pair was "more like a real word". Since the tape recorder and slide projector worked in synchrony, subjects saw (and/or heard) each word for 7 seconds. Each word was pronounced twice.

The 49 one-syllable word pairs from 3 to 6 letters in length were constructed to be representative of the conditional constraints of English spelling patterns (Venezky, 1970) and are presented in Table 1. They had either their initial or final clusters illegal. The illegal member of the pair was always an anagram of the legal member created by switching the initial or final letter or clusters. For example, a 4-letter, legal nonword tarb was presented with its illegal mate rbat. Rbat has an illegal initial cluster. Some 5-and 6-letter words had both clusters illegal.

Results and Discussion

The data were analyzed in a five-factor repeated measures analysis of variance. The between subjects factors were grade, sex, condition, and performance on the AAT. The repeated factor was type of word with various combinations of word length and position of the illegal cluster. Since subjects' scores on each of the 10 types of words was some proportion of the number of each type, the data were treated with an arcsine transformation.

The main effects of grade, condition, and words were significant ($F(1,48) = 22.40$, $p < .001$; $F(2,48) = 4.60$ $p < .025$; $F(9,432) = 9.46$, $p < .001$, respectively). There was no main effect of sex ($F < 1$). Children's performance on the AAT distinguished between subjects at a marginally significant level ($F(1,48) = 3.66$, $p < .10$), indicating that subjects who scored high on this test made more correct responses than subjects who

scored low. While the AAT was designed for use with prereaders, auditory analysis skills apparently maintain their importance to reading skill through the first and second grades. The important grade X condition interaction was significant ($F(2, 48) = 16.70$, $p < .001$) as well as the interaction of condition X words ($F(18, 432) = 1.91$, $p < .05$).

Table 2 presents the mean percent of correct responses in each condition and grade. Simple effects tests indicated that the main effect of grade was due entirely to the Visual condition. With the nonwords presented visually, first graders performed only 3 percent above chance while the second graders had 82.5 percent correct. This represents a dramatic improvement in the abstraction of English spelling patterns between the first and second grade.

If the redundant auditory information was used by the children, then scores in the Combined condition should be higher than scores in the single modality conditions. This is in fact what happened in the first grade. The simple effect of condition was significant in the first grade ($F(2, 48) = 9.07$, $p < .01$) and individual comparisons indicated that the Combined or audio-visual condition was significantly different from the Auditory and Visual conditions ($F(2, 48) = 7.30$, $p < .005$; $F(2, 48) = 17.72$, $p < .001$). Thus, second graders do best when the words are presented visually, while first graders do best in the Combined condition where both visual and auditory information is presented simultaneously. Contrast analyses on the type of word factor revealed a significant linear and quadratic effect of word length ($F(1, 432) = 44.83$, $p < .001$ and $F(1, 432) = 13.05$, $p < .001$ respectively) indicating that the discrimination tended to be easier when the word pairs were shorter. And, replicating previous research, e.g., Marchbanks and Levin (1965), words with their illegal consonant cluster in the initial position in the word were significantly easier than words with the illegal cluster in the final position ($F(1, 432) = 8.36$, $p < .005$).

However, words with both clusters illegal were no easier than words with either cluster illegal ($F < 1$). An additional finding worthy of note is that children's performance on this task correlated significantly ($r = .50$) with their scores on a standardized reading test. Thus, knowledge of spelling patterns does reflect reading ability measured in other ways.

On the surface, it appears that the main question motivating this study has received an affirmative answer. That is, children in the first grade, just learning how to read, somehow integrate redundant auditory information with the information available in the visual display, to increase the likelihood that they will select a legal nonword as being "more like a real word". However, there is another possible interpretation which the between subjects design of the present study is not equipped to answer. It is possible that the first grade children in the Combined condition selected the modality they did best in and relied on that to make their discriminations. This selection explanation is given weight when it is noted that second graders' performance significantly declined in the Combined condition. In most experiments on cross-modal integration older children do better than younger ones.

To disambiguate these findings, my colleague Richard Rosinski and I are presently carrying out a repeated measures design using these same stimuli with first and second graders. Each child gets half the word pairs in each of the single modality conditions. After one week children will be given the Combined condition. If their scores in the Combined are higher than their scores on their best single modality, they may be integrating the two types of information. Alternatively if their scores in the Combined condition are not higher than their scores on their highest single modality condition it will be concluded that first graders are capable of ignoring information from the modality that is not useful to them and relying on the modality they do well in.

In conclusion, the intra-word redundancies that cause the word superiority effect are apparently abstracted by children after about two years of reading instruction. It will be important to determine if children abstract these redundancies by attending to the auditory information that can accompany the written display. One could postulate that at early stages of learning to read, while children are still engaged in phonemic or auditory decoding, they would rely on their knowledge of the English language in sounding out unknown words. When they produced a sound combination that seemed unlikely, they might return to the word and begin again. In order to understand how to enhance the pick-up of intra-word redundancy in children who do not do it easily and spontaneously, we must continue these experiments to uncover the optimal developmental progression in abstracting the rule system and to further specify what the nature of these rules are so we know what to enhance and when.

TABLE 1

The Stimulus Nonword Pairs

	Number of Letters			
Illegal Cluster Position	3	4	5	6
Initial	TUP - PTU	MECT - CTEM	BOLCH - LCHOB	SPERTH - RTHESP
	MIR - RMI	LIND - NDIL	RINTH - NTHIR	THURLD - RLDUTH
	TEF - FTE	KAFT - FTAK	SHING - NGISH	SHEENK - NKEESH
	GAR - RGA	SULP - LPUS	KAIRK - RKAIK	DOORSH - RSHOOD
	KOL - LKO	RILK - LKIR	FURTH - RTHUF	STOLCH - LCHOST
Final	REG - EGR	GRET - TEGR	SHRAL - LASHR	THWOIN - NOITHW
	RAD - ADR	DRIN - NIDR	TROOK - KOOTR	SCROOT - TOOSCR
	NES - ESN	TWUF - FUTW	DRISH - SHIDR	SPLITH - THISPL
	LUB - UBL	SLAN - NASL	BLOAM - MOABL	STRESH - SHESTR
	WID - IDW	PLIM - MIPL	SNEAD - DEASN	GLURCH - CHURGL
Initial and Final			TROLP - LPOTR	BRILCH - LCHIBR
			GLARM - RMAGL	SCROND - NDOSCR
			BLERG - RGEBL	PLARTH - RTHAPL
			FRECT - CTEFR	PRUNTH - NTHUPR
				TWERSH - RSHETW

TABLE 2

Percent of Correct Responses Within Grade and Condition.

	Condition		
Grade	Auditory	Visual	Combined
1	61.%	53%	72%
2	65%	82.5%	70%

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